Benthowave Instrument Inc.

SE=SL-TL+AG-NL | Acoustical Solutions: SONAR, NDT/AE, HIFU. | benthowave.com | Revised on 2025-7-29

BII7690 Series: Low Q_m NDT & Imaging Transducers for High Axial and Lateral Resolutions

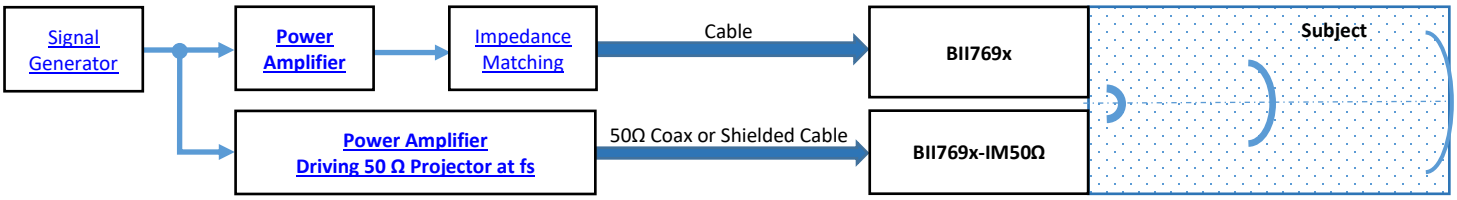
BII7690 series low Q_m (Mechanical Quality Factor) broadband ultrasonic transducers (Longitudinal, Shear Wave, and Guided Waves) are designed primarily for use in ultrasonic pulse system: short-distance echo sounding underwater, NDT/AE (Non-destructive Testing), and Acoustical Imaging (Microscope, Holography, and Tomography). The typical Q_m is from 1 to 3 which results in clean pulse responses. Physical focusing of Concave (bowl or spherical sector) acoustic apertures are available to increase lateral resolution and sensitivity. Dynamic focusing (Total Focusing Method TFM) and beam steering are implemented with linear (rectangular) array (referring to BII7630 Series Phased Array Transducer) and Annular Array (referring to BII7740 Series Annular Array.).

These transducers are immersion transducers and contact transducers. The couplant (water, gel, grease, oils, commercial couplant, and shear-wave couplant) is a necessary material to provide efficient acoustic coupling between the transducer face and the subject (piece under test). High resolution image can be formed with the techniques of **Synthetic Aperture Imaging** and **Synthetic Aperture Sequential Imaging**.

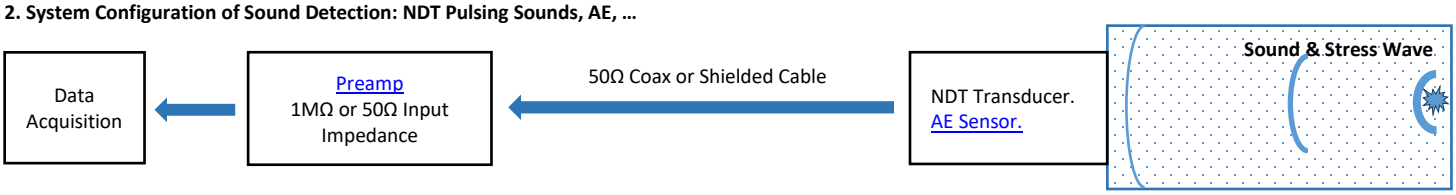
Plastic and rubber housing resist attack by acids, alkalis, salt solutions and most other chemicals. There is no risk of corrosion when exposed to naturally corrosive conditions. They will not rust or corrode from electrochemical and galvanic environment. Solvents shall not be used with transducers, such as hydrochloric acid, isopropyl alcohol, ethyl lactate, acetone, xylene, Iso hexanes, mineral spirits, etc.. DO NOT use the transducers with flammable and/or explosive materials.

NDT Transducer Types:	Single Element Transducers	Focusing Transducer	Dual Element Transducer
Typical Applications			
Sound Velocity Profiler/Velocimeter/Velocity Probe. Short Range Communication & Navigation, Underwater Robot. Object Detection/Tracking, Obstacle Avoidance. Underwater Distance Gage, Altimeter, Liquid Level Detector.		B-Mode Imaging, Doppler Ultrasound, Diagnostic Ultrasound, Thermoacoustic Tomography. Physical Acoustics, Materials & Fluids Characterization, Shear Wave Impedometry. Flaw Detection, Thickness Gaging, Process Control. Maintenance/Inspection of Underwater Structure/Structural Health Monitoring.	

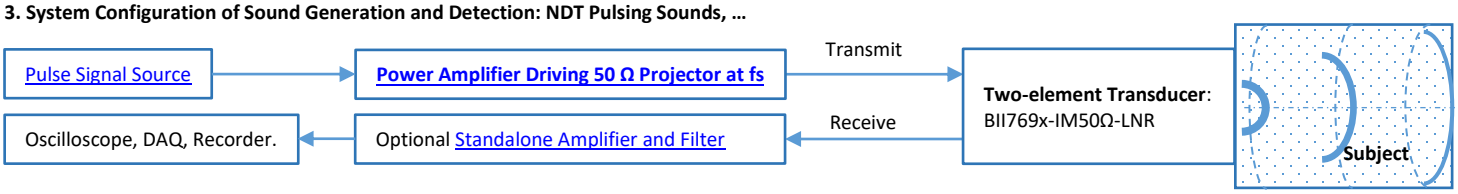
1. Generation of Underwater or Ultrasonic Sounds.

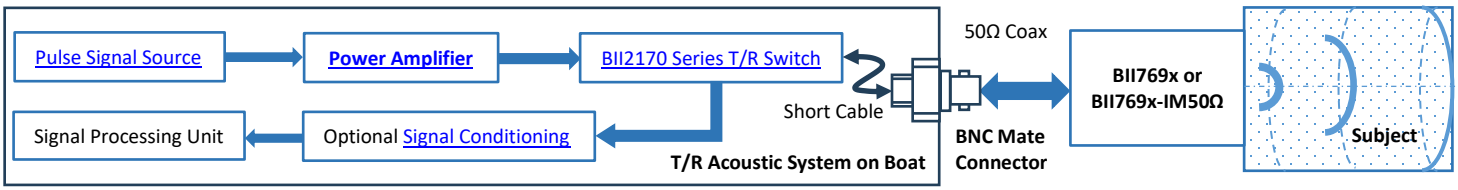


2. System Configuration of Sound Detection: NDT Pulsing Sounds, AE, …



3. System Configuration of Sound Generation and Detection: NDT Pulsing Sounds, …





Useful Formula and parameters for Selecting Ultrasonic Transducers		
Q: Lumped System Quality Factor; **λ**: Wavelength; **D**: Aperture Diameter; **F**: Focal Length of Disk or Concave Aperture; **FWHM**: Full Width at Half Maximum. **MIPP**: Maximum Input Pulse Power. **MPW**: Maximum Pulse Width. **MCIP**: Maximum Continuous Input Power.		
Best Axial Resolution ≈ 0.95Q*λ.	Best Lateral Resolution = Minimum Beam Width ≈ FWHM = 1.4λ*F/D.	Near Field Length N = $D^2/(4\lambda)$.
Rayleigh Distance = $\pi D^2/(4\lambda)$.	Fraunhofer Zone Distance = $2.3D^2/(4\lambda)$.	Angle of Divergence = $\sin^{-1}(1.22\lambda/D)$
Wave Mode Conversion at Oblique Incidence: L, S, Rayleigh (Surface), Lamb, Stonely, and Scholte Waves, Snell's Law: $\sin\theta_L/C_L = \sin\theta_L'/C_L' = \sin\theta_s'/C_s'$. Bespoke Acrylic or Plexiglas (or other engineering plastics such as Polystyrene, Nylon, PTFE, etc…) Wedge are available. Please specify physical size when ordering.		
Immersion Testing from Water to Steel: First Critical Angle: 15°, compressive wave to shear wave mode conversion. Second Critical Angle: 27°, shear wave to surface wave mode conversion.		**Contact Testing from Plexiglas to Steel:** First Critical Angle: 28°, compressive wave to shear wave mode conversion. Second Critical Angle: 58°, shear wave to surface wave mode conversion.

NDT Transducers

L-wave Transducers. In-water Parameters. -3dB BW: one-way beam width; TVR unit: dB µPa/V@1m; FFVS (Free Field Voltage Sensitivity) unit: dB V/µPa.

Single Element Transducers: The single element is to transmit sounds and/or receive sounds.

fs MHz	Disk Element Size ΦD (mm)	TVR in water	FFVS in water	-3dB BW in water	MIPP (W)	MPW (s)	MCIP (W)	Housing Size ΦODxH (mm)
0.2	Φ38.1	158.5	-190.6	11.2°	3000W	1.3s	15W	Φ48x(20 to 40)
0.5	Φ38.1	161.0	-200.6	4.6°	600W	1.0s	10W	Φ48x(20 to 40)
0.5	Φ10.0	140.0	-200.6	17.5°	150W	0.2s	2W	Φ16x25.4
0.6	Φ25.4	167.0	-192.0	9.0°	480W	0.8s	20W	Φ33x(20 to 40)
1.0	Φ25.4	172.0	-197.6	3.4°	300W	0.8s	10W	Φ33x(20 to 40)
1.0	Φ10	150.0	-213.0	8.8°	47W	0.8s	2W	Φ21x(15 to 20)
2.0	Φ25.4	186.0	-213.5	1.7°	350W	0.3s	15W	Φ33x(20 to 40)
2.25	Φ25.4	187.0	-213.0	1.5°	300W	0.35s	13W	Φ33x(20 to 40)
2.8	Φ3.0	146.0	-213.0	15.8°	20W	0.01s	0.1W	Φ7.5x17
3.5	Φ19.0	190.0	-217.0	1.3°	173W	0.2s	7.5W	Φ27x(20 to 40)
3.5	Φ5.0	168.0	-217.8	5.0°	33W	0.085s	0.54W	Φ9.52x15
5.0	Φ19.0	188.0	-220.0	1.0°	100W	0.15s	4W	Φ21x(15 to 20)
5.0	Φ12.7	185.0	-220.0	1.4°	76W	0.15s	3W	Φ21x(15 to 20)
5.0	Φ5.0	175.1	-221	3.3°	33W	0.06s	0.55W	Φ9.52x15
7.5	Φ12.7	194.0	-224.0	1.0°	76W	0.1s	3W	Φ21x(15 to 20)
7.5	Φ5.0	182.2	-224.5	2.2°	33W	0.04s	0.56W	Φ9.52x15

Dual Element Transceivers: Large aperture element: transmit sounds; Small aperture element: receive sounds. Both elements are isolated acoustically.

fs MHz	Transmit Aperture ΦD (mm)	Receive Aperture Φd (mm)	TVR in water	FFVS in water	-3dB BW: Transmit x Receive, in water.	MIPP (W)	MPW (s)	MCIP (W)	Housing Size ΦODxH (mm)
0.5	Φ38.1	Φ3	160	-213.0	5.2° x 60°	500	10	10	Φ60x(20 to 40)
1.0	Φ25.4	Φ3	172	-213.0	3.4° x 30°	300	0.8	10	Φ42x(20 to 40)
2.25	Φ25.4	Φ3	187	-213.0	1.5° x 13°	300	0.35	13	Φ42x(20 to 40)

Focusing Transducer: Focusing Elements ΦD x F. ΦD: Aperture Diameter, F: Focal Length. Bespoke aperture size and focal length are available on request.

✓ is in-stock element, x is NOT recommended.

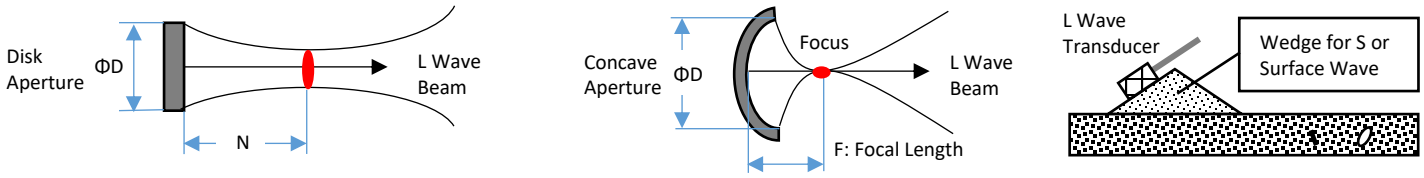
fs (MHz)	Φ38x32mm	Φ33x23mm	Φ19x36mm	Φ12.7x25mm	Φ9.5x20mm	Φ6.35x15mm
0.5	✓	✓	x	x	x	x
1	✓	✓	✓	x	x	x
2	✓	✓	✓	✓	✓	✓

Housing Material:	1. Default: Corrosion Resistance, Rust-free: Plastics and Rubbers. 2. Customization: 316/316L SS Housing is available on request.
Wave Type:	Longitudinal, Compressional or Compression Wave. Water, gel, grease, oils or commercial couplant should be used.
Pulse Driving Signal: (For Fundamental fs)	Spike (Negative or Positive) and SINE/Chirp/FM pulses. Warning: High power continuous signal should not be used to drive transducers which shall be destroyed by overheating. **How to determine pulse width, duty cycle and off-time with input pulse power (peak power):** 1. Determine the input pulse power (IPP, peak power) with sound intensity required by the project. IPP MUST be less than MIPP. 2. Pulse Width ≤ (MIPP * MPW*(120°c-T)/103°c)/IPP. T: Water Temperature in °c. 3. Duty Cycle D ≤ MCIP*(120°c-T)/103°c)/IPP. 4. Off-time ≥ PW*(1-D)/D.
Third Harmonic:	2.9fs ~ 3.2fs; Transducers can operate at 3fs and an impedance matching network at 3fs should be used. Pulsing Signal Driving ONLY: Duty Cycle ≤ 1%, Pulse Length ≤ 1 mS.
Mechanical Q_m:	1 to 3, Mechanical Quality Factor.
Beam Pattern:	Conical
Side Lobe Level:	≤-17.7 (dB)
Maximum Depth:	100 m Underwater and Limited by the cable length if the cable has wire leads or a non-waterproof connector.
Mounting Options:	1. Default: Free Hanging (**FH**) 2. Thru-hole Mounting with Single O-ring (**THM-M10, THM-7/16", or THM-5/8".)** 3. Thru-hole Mounting with Double O-ring (**THDO-7/16"**) 4. Bolt Fastening Mounting (Stainless Steel) (**BFM-M6, BFM-7/16", or BFM-5/8".**) 5. Bolt Fastening Mounting (Plastics) (**BFMP-M12, or BFMP-NPT3/8".**) 6. Bolt-Fastening Mounting with Free Hanging (**BFM-FH-1/4", BFM-FH-3/8".)** 7. Free-hanging with Male Underwater Connector (**FHUWC-2P, FHUWC-3P, FHUWC-4P, FHUWC-6P.**) 8. End-face Mounting (**EFMS or EFMM.**) 9. Flange Mounting (**FGM-Φ140 or FGM-Φ110.**) 10. Flush Mounting (**FSM-M10, FSM-M14, FSM-M35, FSM-M56**.) Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.
Cable-Out:	Specify when ordering. Please refer to **Housing Types**. 1. Cable goes out of the device from the end face. 2. Cable goes out of the device from the side wall.
Cable:	1. 50 Ω RG58 Coax (**RG58**). 2. 50 Ω RG174/U Coax (**RG174**). 3. 50 Ω RG178/U Coax (**RG178**) (Operating Temperature Range: -70°C To +200°C or -94°F to 392°F). 4. 50 Ω Coax RG316/U (**RG316**) (Operating Temperature Range: -50°C To +200°C or -58°F to 392°F). 5. Two Conductor Shielded Cable (**SC**)
Cable Length:	1. Default: 1m, 2. Custom.

1. **BNC**: "Bayonet Neill–Concelman" is a miniature quick connect/disconnect radio/audio frequency connector used for coaxial cable. Fastening Type: Bayonet Lock.
2. **MIL**: MIL-5015 Style Connectors, interconnection solution for high power signals. –55°C to +125°C, Fastening Type: Threaded. Dry Uses.

3. **UMC**: Underwater Mateable Connectors, interconnection solution for high power or weak signals. Fastening Type: Threaded. Underwater Uses.	
Connector:	1. Default: Wire Leads (**WL**), for Transmit, Receive Signal, and DC Power Supply. 2. Male BNC (**BNC**) (Max. Diameter Φ14.3 mm), for Transmit or Receive Grounded Signal. **BNC with RG178 Coax**: Service Temperature up to 165°C or 329°F. 3. MIL-5015 Style (3 pin) (**MIL3P**) (Max. Diameter Φ19 to Φ30 mm). 4. Underwater Mateable Connector (2 pins) (**UMC2P**) (Max. Diameter Φ21.5 to Φ35 mm). Locking Sleeve: DLSA-M. Underwater Mateable Connector (3 pins) (**UMC3P**) (Max. Diameter Φ21.5 to Φ35 mm). Locking Sleeve: DLSA-M. Underwater Mateable Connectors (**UMC**) are fixed with 0.6m unshielded cable. UMC is from global manufacturers of underwater connectors. Its part number is listed in quote in detail.
Weight:	≥ 0.05 kg with 1 m cable. Actual weight depends on Mounting Parts, Cable Types and Length.
Operation Temperature:	1. Default: -10 to +60 °C, or 14 to 140 °F. 2. **Customized High Temperature Transducer**: -15°C to 198°C or 5°F to 390°F. Append **-HT** to Transducer Part Number.
Storage Temperature:	-20 to +60 °C, or -4 to 140 °F.
Impedance Matching at f_s:	50Ω Impedance Matching: **-IM50Ω**. BIIxxxx-IM50Ω: BIIxxxx transducer with built-in Impedance Matching Network as 50Ω load at fs.
	Phase Angle |θ| of Complex Impedance ≤ 20° at fs.
TR Switch:	BII2100 Transmitting & Receiving Switch Module with Built-in Preamp and Bandpass Filter. Order Separately as standalone devices
Amplifier:	BII5000 Power Amplifiers for SONAR, NDT, HIFU. Order Separately as standalone devices.
Pulser-Receiver:	BII8010 series Ultrasonic Pulser-Receiver.
WARNING: DANGER — HIGH VOLTAGE on wires. Wires shall be insulated for safety. DO NOT TOUCH THE WIRES BEFORE THE DRIVING SIGNAL IS SHUT DOWN. Cable shield must be grounded firmly for safety.	
for 50Ω BNC connector, it is buyer's sole responsibility to make sure that the BNC shield of the signal source is firmly grounded for operating safety before hooking up transducer/hydrophone to the signal source. Coax with BNC is not intended for hand-held use at voltages above 30Vac/60Vdc.	
These products are tested and calibrated in water. It is buyer's responsibility and liability to calibrate and maintain the transducers according to respective NDT national standards of buyer's country.	

Aperture Options of Single Element:



Dual-Element NDT Transducer: Large Aperture for Emitting NDT Sounds, Small Aperture for Receiving Echoes.

How to Order: Bespoke Acrylic or Plexiglas (or other engineering plastics) Wedge are available. Please specify physical size when ordering.

Part Number	**-Aperture Size**	**-Mounting**	**-Cable Length**	**-Cable**	**-Connector**
BII7691, BII7693.	**Single Element Disk Aperture**: ΦD x Frequency **Concave Aperture**: ΦD x F x Frequency **Dual Element Disk Aperture**: ΦD x Φd x Frequency	Refer to the options	in meter	Refer to the options	

Example	Description
BII7691-Φ38.1mmx0.1MHz-1m-SC-UMC	BII7691, NDT Transducer, Single Element Disk Aperture: Φ38.1mmx0.1MHz, 1m Shielded Cable, Underwater Mateable Connector (Pin).
BII7693-Φ5mmx7.5MHz-1m-RG174-BNC	BII7693, NDT Transducer, Single Element Disk Aperture: Φ5mmx7.5MHz, 1m RG174/U, BNC Male.
BII7691-IM50Ω-Φ5mmx7.5MHz-1m-RG174-BNC	BII7691, NDT Transducer, Impedance Matching to 50Ω; Single Element Disk Aperture: Φ5mmx7.5MHz, 1m RG174/U, BNC Male.
BII7693-Φ38x32mmx2MHz-1m-RG178-BNC	BII7691, NDT Transducer,Concave Aperture: Φ38x32mmx2MHz, 1m RG178B/U, BNC Male.
BII7691-Φ38mmxΦ3mmx0.5MHz-1m-RG174-BNC	BII7693, NDT Transducer, Dual Element Disk Aperture: Φ38mmxΦ3mmx0.5MHz, Two x 1m RG174/U, BNC Male. Note: Large Aperture: Emit Sounds; Small Aperture: Receive Sounds.

Wiring Information.

Transducer Wiring:	**Shielded Cable**	**Coax, BNC.**	**UMC3P, Locking Sleeve: DLSA-M.**	**MIL3P**
Signal:	White or Red	Center Contact	Contact 2	Contact C or G
Signal Common:	Black	Shield	Contact 1	Contact B
Shielding and Grounding	Shield	Shield	Contact 3	Contact A

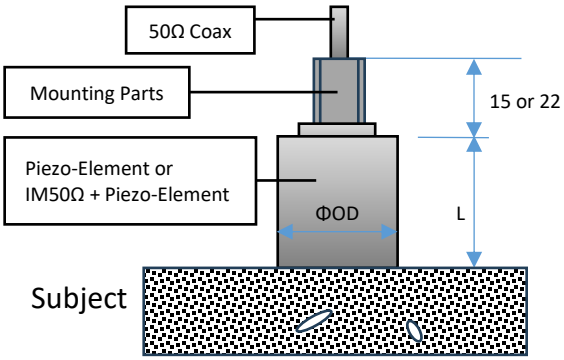
Physical Size (Dimensional Unit: mm): The overall length varies with the length of mounting parts.

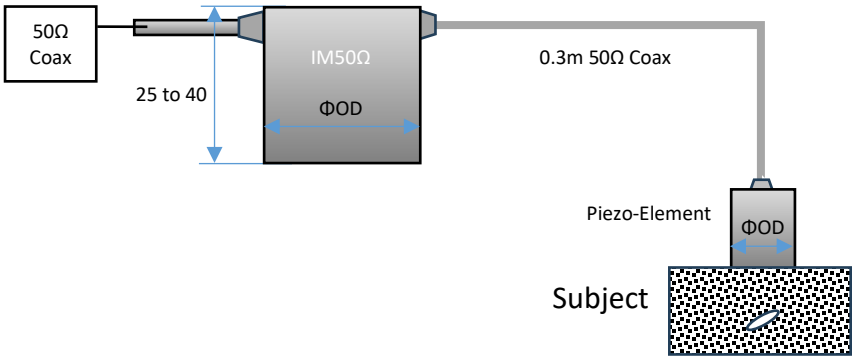
Note: BII determines which of following configurations to be used for buyer's order.
Configuration (1) for large aperture: Both Piezo-element and Impedance Matching IM50Ω are inside one housing.
Configuration (2) for small aperture: Piezo-element and Impedance Matching IM50Ω are separated.
Definition on "small aperture" and "large Aperture" depends on material, shape, and size of magnetic cores at fs and electrical parameters of piezo element at fs.

BII7691 NDT Transducers with Mounting Parts and Cable going out from End faces.

1. Housing OD: Φ9 to Φ60 mm depending on fs and acoustic apertures.
2. Mounting Parts and Coax RG58, RG316/U, RG174/U or RG178B/U goes out from end face of the housing.
   Single Element Transducer: Once Cable; Dual Element Transducer: Two Cables.
   Free hanging (**FH**) with cable gland: hexagonal wrenching flats 18.5mm for clamping.
3. Maximum Underwater Depth: 300 m.
4. **Piezo-element ONLY**: Length L = 15 to 30 mm. **Piezo-element + IM50Ω**: Length L = 40 to 50 mm.

(1) Both Piezo-element and Impedance Matching IM50Ω are inside one housing. **(2) Piezo-element and Impedance Matching IM50Ω are separated.**

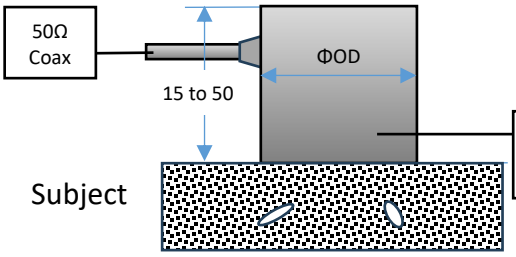


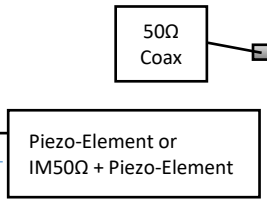


BII7693 NDT Transducers with Flat End Faces for Clamping:

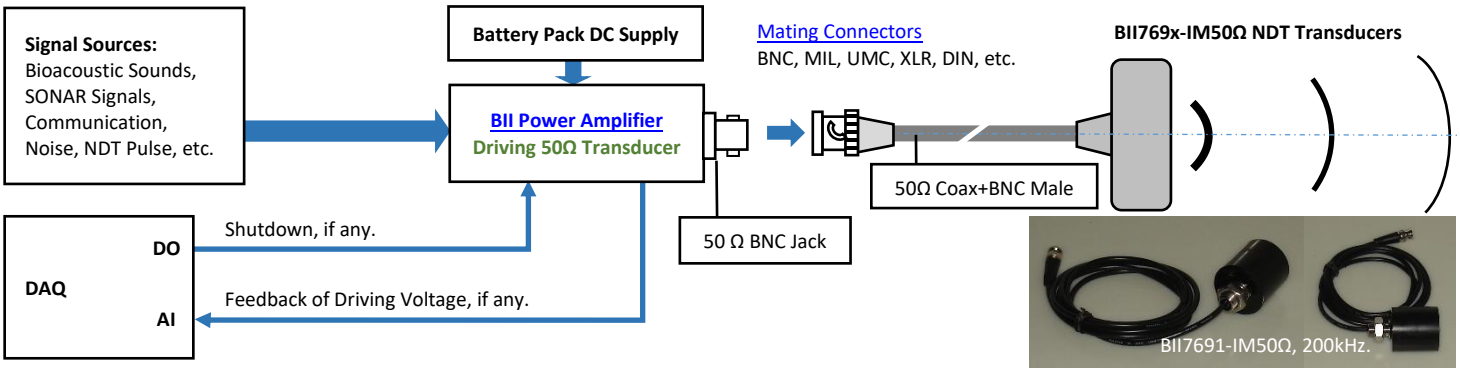
1. Housing OD: Φ9 to Φ60 mm depending on fs and acoustic apertures.
2. Coax RG58, RG316/U, RG174/U or RG178B/U goes out from side wall of the housing.
   Single Element Transducer: Once Cable; Dual Element Transducer: Two Cables.
3. Maximum Underwater Depth: 100 m.
4. **Piezo-element ONLY**: Length L = 15 to 30 mm. **Piezo-element + IM50Ω**: Length L = 40 to 50 mm.
5. Flat End Faces for clamping with compressive force.

(1) Both Piezo-element and Impedance Matching IM50Ω are inside one housing. **(2) Piezo-element and Impedance Matching IM50Ω are separated.**

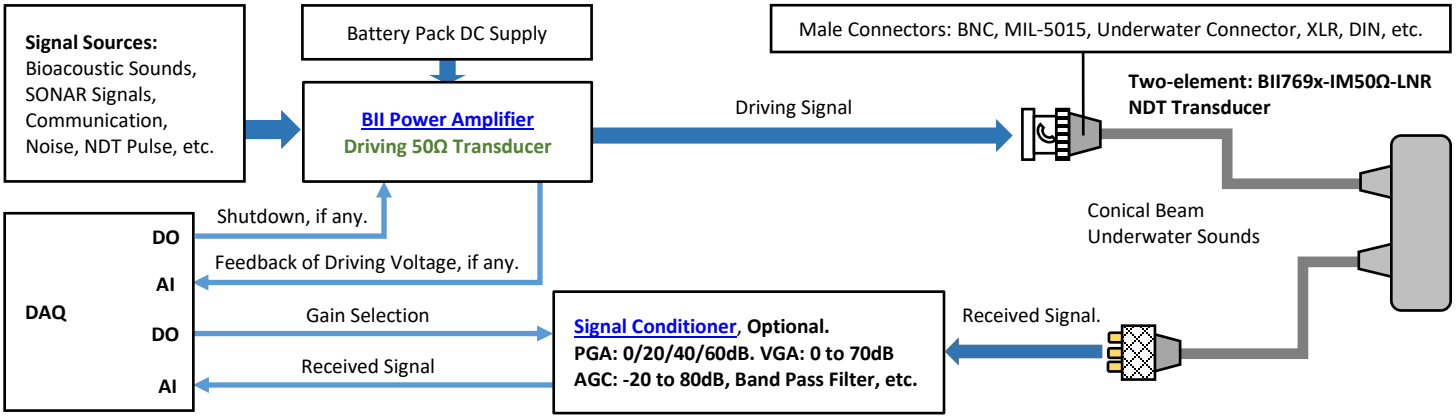




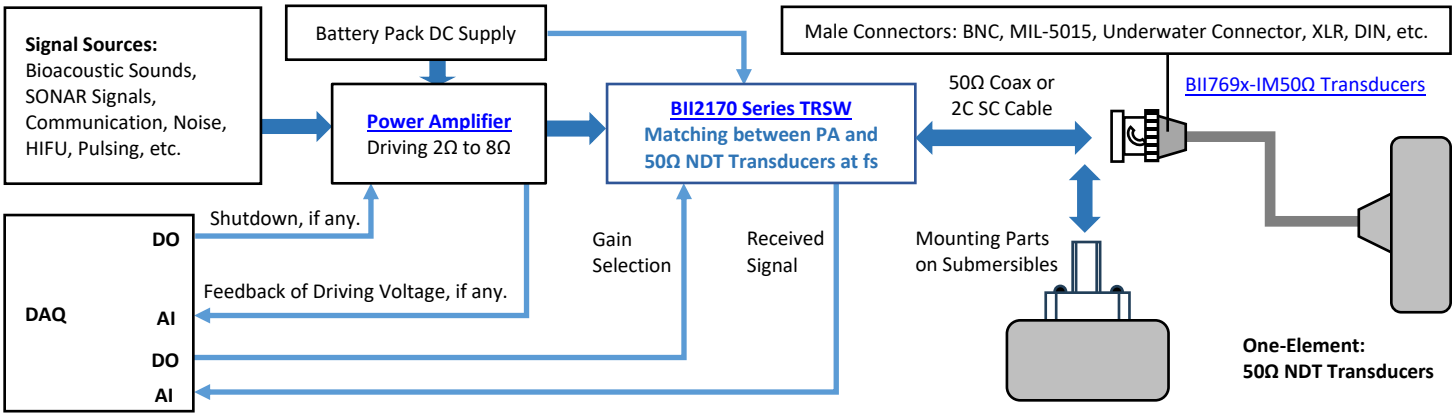
1. Acoustic System of Sound Generation: NDT Pulsing Sounds, … DO: Digital Outputs, AI: Analog Inputs.

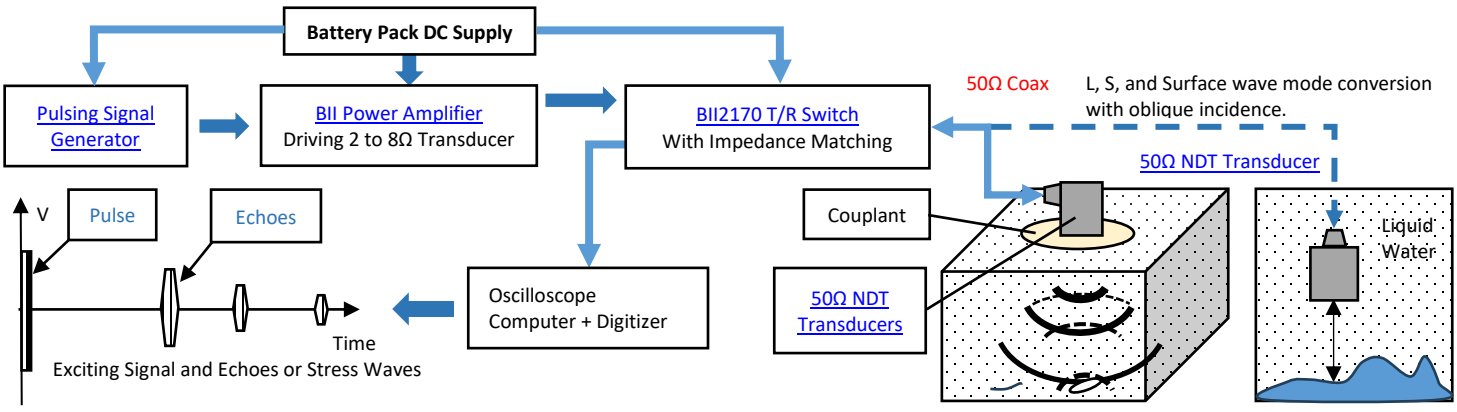


System Block Diagram of Transmitting and Receiving Sounds of Two-Element Transducers: a Simple Configuration. DO: Digital Outputs**, AI:** Analog Inputs**.**



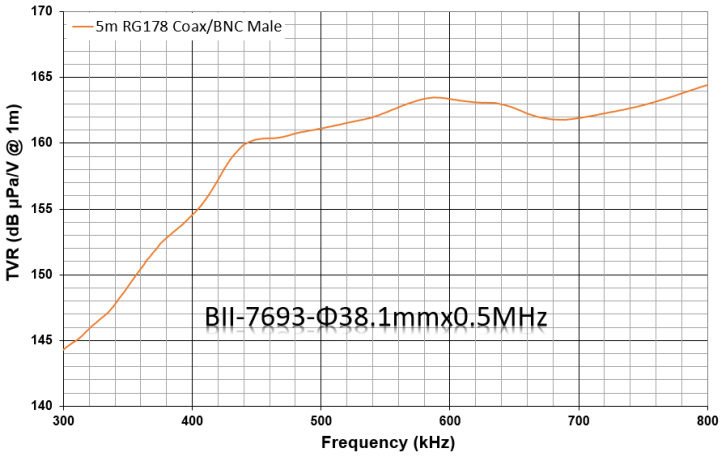
System Block Diagram with 50Ω NDT Transducers (BII769x-IM50Ω).

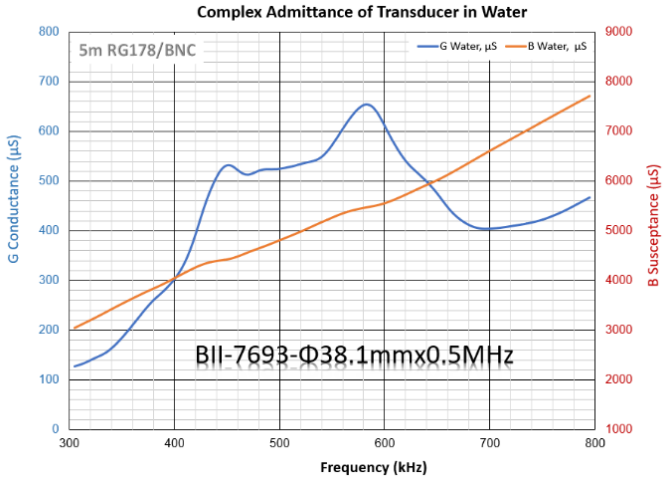




Typical Parameters of Customized Transducers

BII-7693-Φ38.1mmx0.5MHz Transducer





BII-7692-Φ10mmx1MHz Transducer